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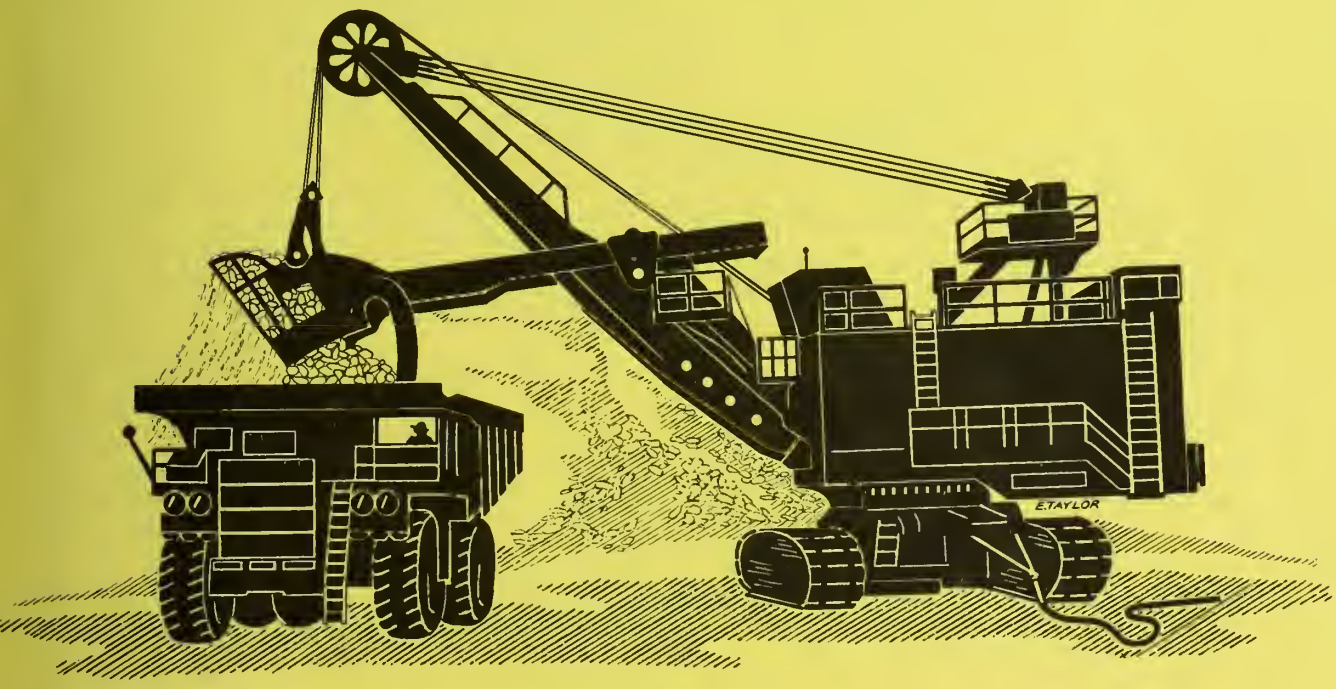
MINERAL COMMODITY REPORT
—— TITANIUM ——
(INCLUDING RUTILE AND ILMENITE)

1984

Part I adapted from
the U.S. Bureau of Mines publication,
Mineral Commodity Summaries, 1984



CALIFORNIA DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY

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CALIFORNIA DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY
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INTRODUCTION

This report on the availability and demand for titanium in California, the United States, and the world is one of a series of Mineral Commodity Reports prepared by the California Division of Mines and Geology to describe commodities of significance to California and the nation.

The first section in this report consists of United States and world-wide mineral statistic information and analysis adapted directly from the U.S. Bureau of Mines Mineral Commodities Summaries (1984). The second section, prepared by the California Division of Mines and Geology, discusses the commodity in California.

Much of the titanium utilized in the United States is obtained from foreign sources, principally Australia, Canada, Sierra Leone, and the Republic of South Africa. Raw materials from these sources are processed in Japan, China, Germany and other countries before being shipped to the United States. In 1982, foreign sources supplied 63% of the rutile and 75% of the ilmenite consumed in this country. These minerals are the major natural sources of titanium.

The greatest uses for titanium metal are in the aerospace industry, in marine use, in valves and pumps for corrosive chemicals, and to strengthen steel. Titanium is a silver-grey metal which is strong under high temperature and is highly resistant to corrosion by acids, alkalis, and sea water. In addition, titanium dioxide (TiO_2) is used by the pigments industry for its excellent whiteness and hiding power.

One important potential source for titanium is anorthosite, a rock type present in Los Angeles County. The concentrations of ilmenite which occur within this rock have been examined in the past and have been found not to be economic due to competing overseas rutile resources and to high ilmenite processing costs. The mitigation of environmental hazards associated with ilmenite processing are also costly. Current research is attacking some of these problems.

Titanium resources are necessary to this country because the physical and chemical properties of titanium are relatively unique and only partial substitutes are known. In 1983, nationwide, about 85,000 workers were employed directly in the titanium-production industry.

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1. UNITED STATES PRODUCTION AND USE

Titanium and Titanium Dioxide: Sponge metal was produced by seven firms, with major production in Nevada, Ohio, and Oregon. Ingot was made by four sponge makers and by six firms located in six states. Twenty-one companies produced titanium mill products, mainly in the east-central region. In 1982, about 60% of the titanium metal was used in jet engines, airframes, and space and missile applications. Of the remainder, about one-half was used in the chemical processing industry, power generation, and in marine and ordnance applications, and one-half in steel and other alloys. The value of sponge metal consumption in 1982 was about $220 million.

Titanium dioxide pigment was produced by six companies at 12 plants in eight States. In 1982, uses of titanium dioxide were in paints, varnishes, and lacquers, 48%; paper, 25%; plastics, 12%; rubber, 2%; ceramics, 2%; and other, 11%. The value of titanium dioxide consumption in 1982 was about $1 billion.

Rutile: Rutile was produced at one mine in Florida in 1982. At two other mines in Florida, rutile was included in a bulk concentrate containing mostly ilmenite and leucoxene. The major coproduct of these titanium minerals is zircon. Of 27 consuming firms, located mainly in the Eastern United States, five companies used 72% of the rutile consumed to make titanium dioxide pigment. Seven firms in Nevada, Ohio, Oregon, Texas, Utah, and Washington used titanium tetrachloride made from rutile to manufacture titanium metal. Welding rod coatings consumed 3%; miscellaneous applications, which include titanium metal and glass fibers, 25%.

Ilmenite: Four firms produced concentrate from five operations in New York, Florida, and New Jersey. Two companies produced about 80% of the total. Over 60% was mined in Florida. Value of mine shipments in 1982 totaled $19 million. Major co-products of sand deposits are zircon and rutile; at one hardrock deposit, magnetite. Ilmenite and titanium slag were consumed by 15 companies. Five titanium pigment producers used 93% of the ilmenite and titanium slag consumed. The rest was used in welding-rod coatings and well-drilling muds, and for metal, alloys, carbide, and chemicals.

2. SALIENT STATISTICS -- UNITED STATES

Titanium and Titanium Dioxide (Data in short tons, unless noted):

Metal:	1979	1980	1981	1983	1983[e]
Production [1]	21,100	22,500	26,400	15,600	13,000
Imports for consumption, sponge	2,488	4,777	6,490	1,354	1,400
Exports (mainly scrap)	8,602	8,880	9,644	8,096	7,700
Shipments from Govt. stockpile excesses				None	

e/ Estimated.

1/ Calculated sponge metal production = sponge consumption - sponge imports + sponge exports and adjustments for Government and industry stock changes.

Metal (Continued):	1979	1980	1981	1982	1983e
Consumption of sponge metal, reported	23,937	26,943	31,599	e17,328	15,000
Price: Sponge per lb., yearend	$ 3.98	$ 7.02	$ 7.65	$ 5.55	$ 5.55
Stocks: Sponge, industry, yearend	2,155	2,381	e3,720	e3,350	3,000
Employment: Reduction plants	1,700	2,000	2,200	1,500	1,500
Net import reliance[2] sponge only as a percent of reported consumption	12	16	16	9	W

Titanium Dioxide:	1979	1980	1981	1983	1983e
Production	742,081	727,245	761,190	635,061	735,000
Imports for consumption	104,968	97,590	124,906	138,922	160,000
Exports	49,369	42,126	61,104	72,823	85,000
Apparent consumption	837,042	753,480	806,040	716,416	814,000
Price: Rutile, per pound yearend	$ 0.59	$ 0.63	$ 0.75	$ 0.75	$ 0.75
Stocks: Producer, yearend	54,008	83,237	102,189	86,933	83,000
Employment	4,800	4,600	4,600	4,400	4,200
Net import reliance[2] as a percent of apparent consumption	11	3	6	12	10

Rutile (Data in thousand short tons of concentrates, unless noted):

	1979	1980	1981	1982	1983e
Production	W	-	W	W	W
Imports for consumption[3]	283	282	202	163	120
Exports	10	18	7	2	3
Shipments from Govt. stockpile excesses			None		
Consumption, reported	314	298	285	239	270
Consumption, apparent	330	W	W	W	W
Prices, per ton:					
F.o.b. Atlantic and Great Lakes ports, last quarter (spot)	$390	$440	$460	$460	$415
Bulk, large lots, f.o.b. Titen, Fla.	-	-	$350	$310	$310
Synthetic, f.o.b. Mobile Ala.	-	$310	$340	$350	$350
Stocks: Mine distributor, and consumer, yearend	e127	e157	e163	176	136
Employment: Mine and mill[4]	455	410	371	361	315
Net import reliance[2] as a percent of reported consumption	100	79	64	63	W

W/ Withheld to avoid disclosing company proprietary data.

2/ Net import reliance = imports - exports + adjustments for Government and industry stock changes.

3/ Includes synthetic rutile.

4/ Employment at three sand deposit operations in Florida, which produced either rutile concentrate or a titanium mineral concentrate, where ilmenite and zircon were major coproducts, and where employees were not assigned to specific commodities.

Ilmenite (Data in thousand short tons of concentrate, unless noted):

	1979	1980	1981	1983	1983[e]
Production	639	549	542	263	W
Imports for consumption[5]	296	552	505	596	560
Exports	Not available			19	10
Consumption, reported[5]	936	1,030	1,109	809	900
Consumption, apparent[5]	1,047	802	1,133	1,055	W
Prices, per long ton:					
Ilmenite:					
54% TiO_2, f.o.b. Atlantic ports	$ 50	$ 55	$ 70	$ 70	$ 70
Domestic, f.o.b. Titen, Fla.	-	-	$ 39	$ 44	$ 44
Slag:					
71% TiO_2, f.o.b. Sorel, Quebec	$ 110	$ 115	$ 135	$ 150	$ 162
85% TiO_2, f.o.b. Richards Bay, Republic of South Africa	-	$ 137	$ 175	$ 175	$ 185
Stocks: Mine distributor, and consumer, yearend[5]	804	1,103	1,017	802	700
Employment: Mine and mill[6]	690	650	603	446	367
Net import reliance[2] as a percent of apparent consumption	39	32	52	75	W

3. RECYCLING

Titanium and Titanium Dioxide: New scrap metal recycled was 10,000 tons in 1983, including estimated use of scrap and ferrotitanium by the steel industry, 3,000 tons; by the aluminum industry, 500 tons; and in miscellaneous alloying uses, 300 tons. Old scrap reclaimed was about 100 to 400 tons. There was no known recycling of titanium dioxide.

Rutile: None

Ilmenite: Insignificant

4. IMPORT SOURCES (1979-82)

Titanium and Titanium Dioxide: Sponge metal: Japan 85%, China 11%, U.S.S.R. 4%. Titanium dioxide pigment: Federal Republic of Germany 30%, Canada 14%, France 13%, Other 32%.

Rutile: Australia 69%, Sierra Leone 14%, Other 8%, Republic of South Africa 9%.

Ilmenite[5]: Australia 57%, Canada 35%, Republic of South Africa 7%, Other 1%.

5/ Includes titanium slag from Canada and the Republic of South Africa, and 7,000 to 15,000 tons per year leucoxene.

6/ Includes operating employees shown under Rutile, subject to the same footnoted comments.

5. TARIFF

Titanium and Titanium Dioxide:

	Number	Most Favored Nation (MFN) 1/1/84	Most Favored Nation (MFN) 1/1/87	Non-MFN 1/1/84
Waste and scrap metal	629.12	11.3% ad val.	7.2% ad val.	25.0% ad val.
Unwrought metal	629.14	16.5% ad val.	15.0% ad val.	25.0% ad val.
Wrought metal	629.20	16.5% ad val.	15.0% ad val.	45.0% ad val.
Titanium dioxide	473.70	6.6% ad val.	6.0% ad val.	30.0% ad val.

Rutile:

	Number	Most Favored Nation (MFN) 1/1/84	Most Favored Nation (MFN) 1/1/87	Non-MFN 1/1/84
Rutile ore	601.5140	Free	Free	Free
Synthetic rutile[7]	603.7010	6.0% ad val.	5.0% ad val.	30.0% ad val.

Ilmenite:

	Number	Most Favored Nation (MFN) 1/1/84	Most Favored Nation (MFN) 1/1/87	Non-MFN 1/1/84
Titanium ore (including ilmenite and ilmenite sand)	601.5120	Free	Free	Free
Titanium slag	631.6200	Free	Free	Free

6. DEPLETION ALLOWANCES

Titanium and Titanium Dioxide: Not applicable.

Rutile : 22% (Domestic), 14% (Foreign).

Ilmenite: 22% (Domestic), 14% (Foreign).

7. GOVERNMENT STOCKPILE

Titanium and Titanium Dioxide: The General Services Administration announced on October 28, 1983, the award of contracts for the purchase of 4,500 tons of primary titanium for the stockpile: 3,000 tons from Japan, 1,000 tons from the largest U.S. producer, and 500 tons from the United Kingdom, to be delivered by September 2, 1984. In addition to quantities shown below, the stockpile contains 10,866 tons of nonstockpile-grade sponge metal.

Stockpile Status--11-30-83

Material	Goal	Total Inventory	Authorized For Disposal	Sales, 11 Months
Stockpile grade	195,000 short tons	21,465 short tons	-	-

7/ The suspension of duty on synthetic rutile was extended until June 30, 1982, as provided by P.L. 96-467.

Rutile:

Stockpile Status--11-30-83

Material	Goal	Total Inventory	Authorized For Disposal	Sales, 11 Months
Rutile	106	39	-	-

Ilmenite: None.

8. EVENTS, TRENDS, AND ISSUES

Titanium and Titanium Dioxide: Domestic titanium sponge production increased gradually in 1983, but was only about 50% of capacity at yearend. Further recovery will depend mainly on the level of demand in the commercial aircraft industry, and on increases in defense orders, particularly for the B-1 long range combat aircraft. Several companies were adding new processing facilities or arranging joint ventures with Japanese firms to increase their ability to participate in the nonaerospace part of the titanium market.

Two producers of chloride-process titanium dioxide announced plans for expansion, one by adding to currently-owned capacity, and the other by purchasing an operating plant from another producer. List prices of titanium metal and titanium dioxide were being discounted in 1983 by as much as 25% and 20%, respectively.

It is estimated that in 1984 U.S. production of titanium sponge will be 18,000 tons, apparent consumption of sponge will be 20,000 tons, production of titanium dioxide pigment will be 760,000 tons, and apparent consumption of pigment will be 840,000 tons.

From a 1980 base, demand for titanium sponge is expected to increase at an average annual rate of about 5% through 1990. From a 1980 base, demand for titanium dioxide is expected to increase at an annual rate of about 2% through 1990.

Titanium dioxide pigment plant effluents consist mainly of sulfuric acid, ferrous sulfate, and ferric chloride. Disposal methods include neutralization, deep-well disposal, and barging out to sea.

Rutile: Production of rutile increased in 1983. Production of synthetic rutile at the only U.S. synthetic rutile plant at Mobile, Alabama, was about the same as in 1982. Production of natural rutile in Australia, which in 1982 was the source of about 64% of the world's supply, was nearly the same as in 1982. United States imports from Australia of natural and synthetic rutile totaled 75,000 tons, 23% less than in 1982. Synthetic rutile imports in 1983 were about 20,000 tons compared with 24,000 tons in 1982, and came from Taiwan, 75%, Australia, 46%, and Japan, 5%. It is estimated that in 1984 reported consumption of rutile will be 290,000 tons. From a 1981 base, demand for natural and synthetic rutile is expected to increase at an annual rate of about 2% through 1990.

A major impediment to more extensive use of natural rutile was the limited supply. On the east coast of Australia, the reserve base of rutile is about 6 million tons but because of environmental concerns, only about 4 million tons can be mined. Deposits on Australia's west coast may contain 4 million tons of minable rutile. Production in Sierra Leone was resumed in January 1983 after being suspended in September 1982.

Mining of rutile is entirely from sand deposits which contain only a few percent of valuable minerals. While the discarded sand can be readily returned to the mined area, regraded and seeded to aid restoration of the environment, there was increasing pressure to curtail sand mining in some areas.

Fewer environmental pollution problems are encountered when pigment is made from rutile rather than ilmenite. The chloride process, using a rutile feed, generates 0.2 ton of waste per ton of titanium dioxide product, while the alternate sulfate process, using ilmenite, generates about 3.5 tons of waste per ton of product. Making synthetic rutile from ilmenite results in about 0.7 ton of waste, mainly iron oxide, per ton of product. Direct chlorination of ilmenite generates about 1.2 tons of waste, mainly ferric chloride, per ton of titanium dioxide.

Ilmenite: In 1983 domestic mine production of ilmenite remained at a relatively low level because of lower production at Tahawus, N.Y., although production increased in Florida. Imports were 6% less than those of 1982.

It is estimated that in 1984 U.S. consumption of ilmenite will be 1 million tons. From a 1979 base, demand for ilmenite is expected to increase at an annual rate of about 2% through 1990.

Environmental problems related to ilmenite include: (1) Land-use conflicts where blacksand deposits exist, principally along the Atlantic coast, and (2) the potential for water pollution from pigment-producing processes that use ilmenite - up to 3.5 tons of waste per ton of product using the sulfate process, and 1.2 tons of waste per ton of product from the chloride process. Solutions to the latter problem include the development of economic and environmentally acceptable processes for making synthetic rutile or titanium tetrachloride from lower-grade ilmenites, and the development of methods to neutralize and control the effluents now produced. Two companies treated their spent acid effluent with calcium carbonate and lime, producing a gypsum byproduct which they sold to wallboard and cement manufacturers. One company upgrades part of its waste ferric chloride effluent for use in water treatment, and uses deep-well disposal of ferric chloride at most of its pigment plants.

The only domestic synthetic rutile plant, at Mobile, Alabama, continued in operation in 1983, using Australian ilmenite as feed material.

9. WORLD MINE PRODUCTION AND RESERVE BASE

Titanium Sponge Metal Production and Sponge and Pigment Capacity (short tons):

	Sponge Production		Capacity 1983	
	1982	1983e	Sponge	Pigment
United States[1]	15,600	13,000	33,500	918,000
Finland	-	-	-	88,000
France	-	-	-	182,000
Germany, Federal Republic of	-	-	-	364,000
Japan	18,600	12,000	36,000	250,000
United Kingdom	2,600	2,000	5,500	242,000
Other Market Economy Countries[e]	-	-	-	543,000
China	1,500	1,500	3,000	20,000
U.S.S.R.	44,000	44,000	50,000	137,000
Other Centrally Planned Economies	-	-	-	84,000
World Total	82,319	72,500	128,000	2,828,000

Rutile (thousand short tons of concentrate):

	Mine Production		Reserve Base*
	1982	1983e	
United States	W	W	3,000
Australia	243	240	10,000
Brazil[e]	-	-	100,000
India[e]	9	10	4,000
Italy	-	-	6,000
Sierra Leone[e]	53	80	4,000
South Africa, Republic of[e]	52	60	7,000
Sri Lanka	14	15	6,000
Centrally Planned Economies[e]	10	10	3,000
World Total	[8] 381	[8] 415	143,000

Ilmenite (thousand short tons of concentrate):

	Mine Production		Reserve Base*
	1982	1983e	
United States	509	260	96,000
Australia	1,474	1,340	52,000
Canada (Slag production)	840	720	164,000
Finland	175	160	10,000
India	208	175	71,000
Malaysia	160	135	2,000
Norway	725	620	167,000
South Africa, Republic of (Slag production)	420	400	133,000
Sri Lanka	88	80	49,000
Other Market Economy Countries	17	20	6,000
China	150	150	90,000
U.S.S.R.	475	475	15,000
World Total	4,577	4,140	855,000

10. WORLD RESOURCES

Titanium and Titanium Dioxide: The source of titanium for domestic sponge production was rutile. For pigment production the sources were ilmenite, slag, and rutile. The U.S.S.R. reportedly used a high-grade titaniferous slag for sponge metal production.

Rutile: Identified world resources of rutile (including anatase) total about 200 million tons of contained TiO_2. Major rutile resources occur in Australia, India, Italy, Sierra Leone, the Republic of South Africa, and the United States. The Brazilian resources are mainly anatase, and were reportedly being developed.

Ilmenite: Ilmenite supplies about 90% of the world's demand for titaniferous material. World ilmenite resources total about 1 billion tons of titanium dioxide. Major resources occur in Australia, Canada, India, Norway, the Republic of South Africa, the United States, the U.S.S.R., and China.

11. SUBSTITUTES

Titanium and Titanium Dioxide: For aircraft and space use there is essentially no substitute for titanium. For industrial uses high-nickel steel, zirconium, and to a limited extent the superalloy metals may be substituted. There is no cost-effective substitute for titanium dioxide pigment.

Rutile: Ilmenite, titaniferous slag, and synthetic rutile made from ilmenite may be used instead of natural rutile for making pigment or welding rod coatings.

Ilmenite: Rutile and synthetic rutile were also extensively used to produce titanium dioxide pigment.

8/ Excludes U.S. production.

* Pending establishment of criteria for the reserve base, classification of data is based on a judgmental appraisal of current knowledge and assumptions.

PART II: CALIFORNIA

12. CALIFORNIA GEOLOGICAL OCCURRENCES

Titanium enrichment occurs within four natural environments, each present in California: (1) in association with anorthosite; (2) in metamorphic rocks; (3) with alkalic igneous rock associations; and (4) as placer deposits derived from any of the above. Of the minerals having a high proportion of titanium, rutile and its polymorphs (brookite and anatase) are the most valuable. However, minable concentrations of rutile in metamorphic rocks, alkalic igneous associations, and as a constituent of placers are rarely found in California. Ilmenite ($FeTiO_3$) is a common, lower-grade titanium ore mineral. It can be mined and concentrated from ilmenite, but the process is more costly than titanium extraction from rutile. Ilmenite is abundant in California anorthosite and placer deposits, making these deposits important potential titanium resources.

1. In the crystallization of anorthositic plutons, iron-titanium minerals form late, as discrete layers, lenses, or dikes, commonly associated with apatite. Although rutile is prominent in anorthosite plutons of the eastern United States, it is rare in the San Gabriel Mountains anorthosite complex, where ilmenite is abundant instead.

2. Rutile is a common component of some high-pressure metamorphic rocks. In California, rutile occurs in metabasalt inclusions of blueschist-facies rocks. These rocks formed from the subduction of oceanic basalt at the continental margin. Ilmenite and sphene originating in the basalt may have been converted to rutile during metamorphism.

   Rutile can also form within shear zones in association with melanite garnet and benitoite. Titaniferous silicate minerals of specimen value occur in this association, but economic concentrations of rutile have not been discovered.

3. Titanium concentrations may be present in many types of alkalic igneous rocks associated with carbonatite. Late-stage concentrations of iron-titanium minerals and apatite occur as dikes within this rock type. In California, carbonatite is present, but economic sources of titanium have not been identified.

4. Submarine and terrestrial placer deposits of heavy minerals form adjacent to bedrock titanium occurrences. In California rutile commonly comprises a minor percent of the heavy minerals thus concentrated because it is not abundant in the source rock. In contrast, ilmenite occurs in rich deposits which could be economic due to the low cost of extracting and processing unconsolidated material. Small amounts of ilmenite and rutile, removed during the processing of sand for silica or aggregate purposes, may be available for processing for titanium. At present, the main deterrent to its economic consideration is the high cost of processing ilmenite.

13. CALIFORNIA LOCALITIES

In Los Angeles County, the San Gabriel anorthosite massif (Figure 1), with outcrop exposure of 240 square kilometers, contains ilmenite-bearing rock at several horizons. At some locations, nearly pure ilmenite-magnetite nodules accumulate in streams after being released by weathering. At other locations, in a zone 9 kilometers long, thick sections of ilmenite-magnetite-olivine-apatite rock crop out. Additional portions of the anorthosite massif, offset by faults to locations eastward in Los Angeles County and in Riverside County, include the ilmenite-bearing rock.

High-pressure metamorphic rocks in the Coast Ranges, the foothill belt of the Sierra Nevada, and on Catalina Island contain rutile as a minor but regular component. Locally, titanium is enriched, as in San Benito County where small lenses of massive rutile occur, associated with melanite garnet, benitoite, and neptunite. At locations in Mono County and in Imperial County, metamorphism related to shearing produced rutile and aluminum oxide mineral concentrations. Within the Melones fault zone of the Sierra Nevada foothills, rutile may have developed due to shearing, to the presence of mafic assemblages, or both. Rutile concentrations in schist are known in San Bernardino County.

Carbonatite and related potassium-rich rocks at Mountain Pass in San Bernardino County resembles carbonatites which bear rich deposits of ilmenite, rutile, and brookite in other parts of the world. Only minor rutile has been reported to date at the Mountain Pass location.

Large volumes of ilmenite in placer deposits within and adjacent to the San Gabriel anorthosite complex carry TiO_2 values up to 11%. Additional deposits have accumulated near Redondo Beach in Los Angeles County, from the same source. Ilmenite and rutile-bearing beach placers occur at many other locations along the California coastline. Notable deposits exist near Aptos Creek in Santa Cruz County and near Crescent City in Del Norte County. Rutile has been reported in alluvium of Butte and Nevada Counties.

Ilmenite is an important constituent of glass sands derived from the Ione Formation of central California. Owens-Illinois Corp. extracts quartz sand from Eocene Ione Formation, and generates ilmenite-bearing black sands in the process. The black sands are stored at the Ione facility for possible future sale.

14. CALIFORNIA PRODUCTION

There is no titanium production in California.

Total past production is estimated at 15,000 tons, almost all of which was from Los Angeles County. In 1927-1928, 10,013 tons of ilmenite-magnetite ore was shipped from the San Gabriel anorthosite at Lang Siding, and lesser amounts were extracted from beach sands at Redondo Beach and Hermosa Beach. Earlier attempts at processing ilmenite ore extracted from the anorthosite had been unsuccessful because of its refractory nature.

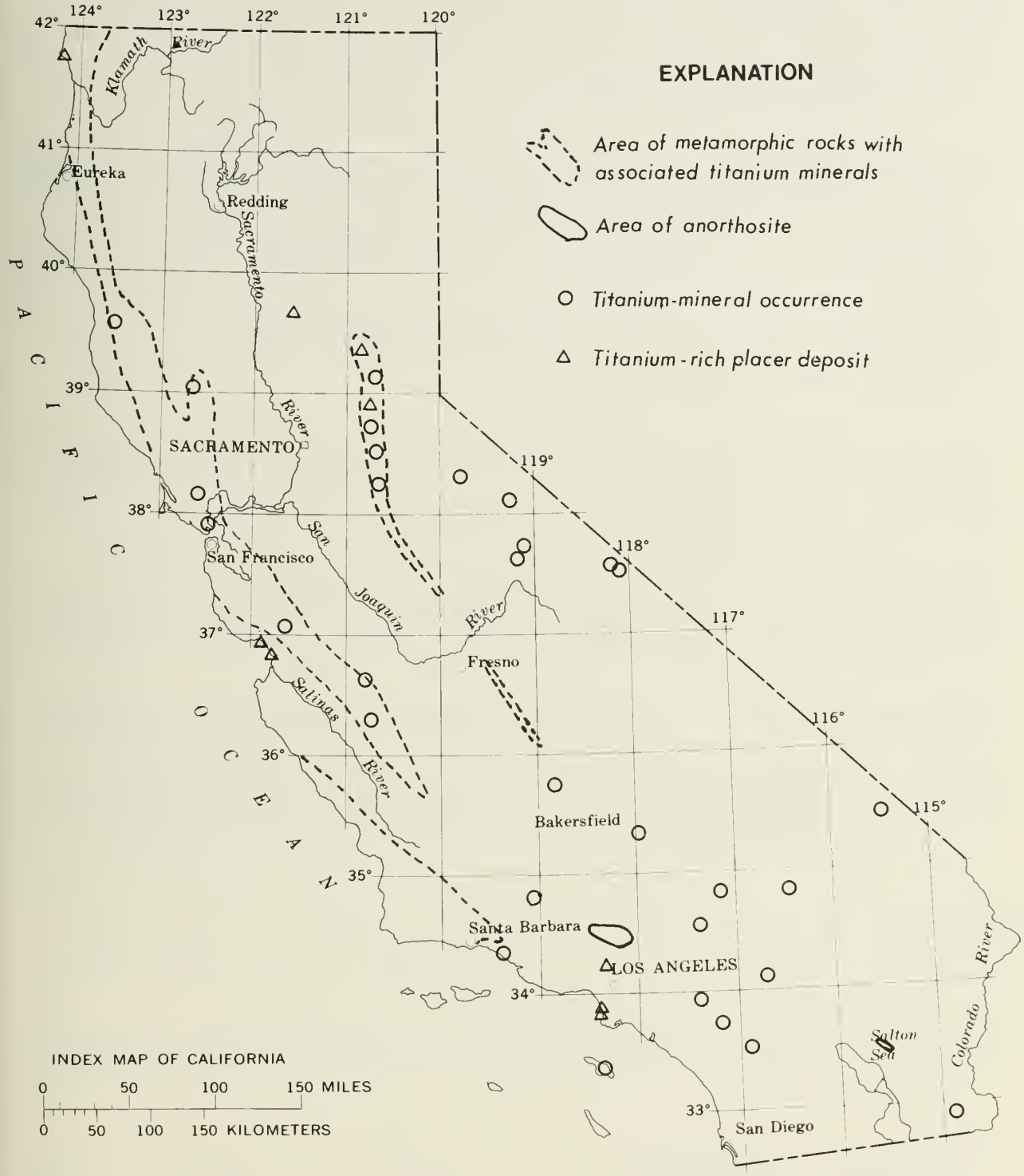

Figure 1. Location of California titanium occurrences.

15. UTILIZATION AND MARKETS

The small volume of titanium ore produced in the past was used in the manufacture of paint base, as roofing granules, and in heavy aggregate.

16. MINING METHODS AND BENEFICIATION

Although bedrock mining of titanium ore requires costly drilling, blasting, and crushing before separation, mining from placer deposits involves extraction and handling of unconsolidated material readily upgraded by gravity and magnetic separation. For this reason, placer ilmenite deposits containing as little as 0.5% TiO_2 have been worked profitably where ilmenite is an economic commodity. In addition, by-product commodities such as iron, vanadium, phosphorus and rare earth elements can enhance the profitability of black sand extraction for titanium minerals.

17. CALIFORNIA EVENTS, TRENDS, AND ISSUES

The environmental problems related to processing titanium ore are discussed above in section 8 relative to the United States as a whole. These have particular significance in California with its dense population, limited water resources, and rigid environmental protection regulations.

The environmental effects of mining beach deposits are perceived to be significant, both visually and with respect to increased noise and traffic in sensitive areas. However, when completed, the net decrease in the volume of beach sediment would not significantly alter the configuration and appearance of California's low-lying coastal terrain.

In mountainous areas, the principal effects of both bedrock and stream placer mining are those concerning the excavation, the construction of haulage roads, and the operation of on-site primary concentrators. In the San Gabriel Mountains, the removal of titanium-rich sand deposits, low in silt content, would have little effect on the water quality of local streams. Material removed from this area would be rapidly replenished.

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